NAME: CLASS PERIOD: DATE:

ALTERNATIVE ENERGY

Investigation

ELECTROLYSIS

Background Information

Voltaic cells The cell is divided into two parts. One part produces free electrons (oxidation), which leave the cell through an external circuit. If a light bulb is in the circuit, it will light. The electrons enter the other part of the cell and are spontaneously bound to other atoms (reduction).

An **electrode** is a conductor in a circuit that carries electrons to or from a substance. The negative electrode, at which electrons are produced, is called the **anode.** The electrode at which electrons are consumed is the **cathode** and is labeled as the positive electrode.

There are several types of voltaic cells. A dry cell is a voltaic cell in which the electrolyte is a paste. For example, a flashlight battery is a dry cell. Lead-acid storage batteries such as those used in cars consist of a group of cells connected together. Fuel cells are voltaic cells in which a fuel undergoes oxidation.

Electrolysis can be used to demonstrate the opposite process: how an electrical current can be converted to chemical energy.

Electrolysis means passing an electric current through an ionized medium to cause a chemical reaction. The container in which electrolysis is carried out is called an electrolytic cell. An electric current passing through an electrolytic cell can trigger chemical reactions that heat alone cannot initiate.

Electrolysis only occurs when enough electrically charged ions are present in an electrolytic medium to carry an electric current. Distilled water does not conduct electric current, because distilled water contains no ions of dissolved salts or minerals. However, the presence of a small amount of an electrolyte such as sodium chloride allows water to conduct electricity. Under these conditions, water (H_2O) can be separated into hydrogen and oxygen.

Electrons flow from the anode to the cathode. When a current is passed through a salt-water electrolyte, positively charged hydrogen ions (H+) are drawn to the anode side of the electrical source. At the anode they gain an electron and become hydrogen atoms (H). Pairs of

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hydrogen atoms then combine to form molecules of hydrogen gas (H_2), which bubbles up from the anode. Similarly, oxygen gas (O_2) is produced at the cathode side of the battery by a process involving the loss of electrons.

A cathode made of metal can become covered or plated with another metal that is part of the electrolyte solution. For example, a spoon that is to be silver-plated may be made the cathode in an electrolytic cell whose anode is made of silver. The electrolyte is an ionized silver compound, i.e., a source of positively charged silver ions that can migrate to the cathode. When an electrical current is applied, silver ions move to the cathode and are deposited on the spoon. They are replaced in the electrolyte by atoms of silver from the anode, which slowly dissolves.

Problem *(fill in problem):* _____

_____

Materials

250 ml beaker
index card
two 15 cm pieces of insulated electrical wire
distilled water
metric ruler
matches
1.25 ml of sodium chloride
two large paper clips
9-volt battery
scissors
wooden splint
styrofoam cup

Procedure

1. Fill a 250 ml beaker with distilled water to within 2.5 cm from the top.
2. Add 1.25 ml of sodium chloride to the beaker and set aside.
3. Straighten the ends of two paper clips, leaving a hook on one end of each.
4. Set paper clips aside.
5. Using one piece of electrical wire, connect one end to the positive battery terminal.
6. Attach the other end of the electrical wire to the paper clip hook.
7. Using another piece of electrical wire, connect one end to the negative battery terminal.
8. Attach the other end of this electrical wire to the paper clip hook.
9. Cut a 5 cm strip from the index card.
10. Insert the straight end of the paper clips through the index card so that they are about 2.5 cm apart.

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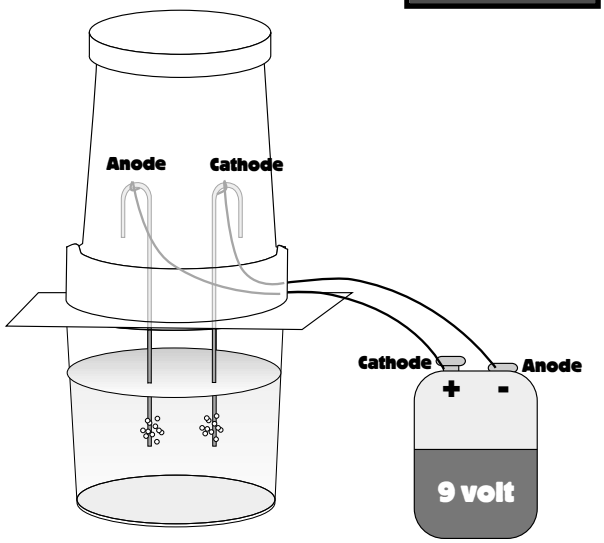
11. Place the trimmed index card over the top of the beaker of salt water so that the paper clips are immersed in the water.
12. Place the styrofoam cup upside down over the beaker.
13. After 5 minutes have elapsed, unhook the battery from the electrical wires.
14. Light the wooden splint. Allow an ember to develop and blow out the flame. The splint should still be glowing.
15. Slowly lift the styrofoam cup up away from the apparatus.
16. Put the glowing splint up into the cup and observe the reaction.



Observations

1. Describe what you saw happening at each end of the paper clips that were beneath the water. _____

   _____

2. Were electrons repelled from the cathode or anode? _____

3. What was the purpose of the electrolyte? _____

4. Explain the chemical reaction that took place. _____

   _____

   _____

5. What gases were trapped in the styrofoam cup? _____

   _____

6. What happened when the burning splint was inserted into the styrofoam cup?

   _____

   What does this indicate? _____

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7. Look at the ends of the paper clips that were submerged in the salt water. What has changed? _____

   Why? _____

Conclusion

8. What is the connection between fuel cells and this electrolysis demonstration?

   _____

   _____

   _____

Application

9. What practical considerations about storing and using hydrogen can be drawn from your observations of its properties? _____

   _____

   _____

10. How could the energy needed to separate hydrogen from oxygen be supplied by the sun?

    _____

    _____

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Going Further

11. Does a chemical reaction occur between the sodium chloride and water solution when the electric current passes through the solution? _____

12. What evidence do you have that a reaction does or does not occur?_____

_____

Extra Credit

13. Metals are plated onto more reactive metals. Nickel is more reactive than copper. Explain the process of plating copper onto nickel.

_____

_____